

WIRELESS DATA COMMUNICATION DEVICE AND  
COMMUNICATION SYSTEM INCLUDING SUCH A DEVICE

The invention concerns a wireless data communication device. The communication device can form part of a portable object, such as a watch. The device includes an oscillator circuit, which produces high frequency signals, and a signal processing unit connected to the oscillator circuit.

5       The invention also concerns a short distance wireless system for communicating data between a communication device and an electronic apparatus.

“Data communication” means either a one-way transmission or a two-way transmission of information or data.

10       In the case of short distance data communication, the portable object, which includes the communication device, can be placed in proximity to or on the electronic apparatus. The signals generally transmitted during a short distance wireless data communication, can be radiofrequency signals, acoustic signals, optical signals or other signals. A combination of these different types of signals can also be envisaged.

15       Within the technical field of data communication, carrying out an exchange of data between two units close to each other, which each include transmission means and reception means for signals, particularly of the radiofrequency type, is known. Since these transmission means are generally different from the reception means, this requires the use of a significant number of electronic components. This can of course be a drawback if these transmission means and reception means have to be fitted to a  
20       portable object, such as a wristwatch. Moreover, such a portable object is generally powered by a battery or an accumulator, which also occupies a significant amount of place. The working of the signal transmission means and reception means involves significant electric power consumption, which can be a drawback, since the battery or accumulator is liable to be discharged too quickly.

25       It should be noted that even if the signal reception means are combined with the transmission means, the communication device has to be switched, either into data signal reception mode, or into data signal transmission mode, by additional electronic elements. This constitutes another drawback in addition to the electric power consumption, which can be relatively high.

30       DE Patent No. 100 26 173 discloses an arrangement for the transfer of electric signals between a base station and at least one external unit. The electric energy is transmitted by a transformer, whose primary winding or coil is placed in the base station and whose secondary winding or coil is placed in the external unit. A data communication can be achieved from the base station to the external unit using the

transformer. A response signal is transmitted from the external unit to the base station by elements for coupling the station and the external unit. These inductive-type coupling elements are different to those of the transformer.

One drawback of such an arrangement is that it is necessary to provide the external unit with specific signal transmission means for data transmission. These transmission means are different from the reception means, which are formed particularly by the secondary transformer coil. Thus, even if the transformer can be used both for charging the accumulator and for data transmission, the additional electronic components of the external unit transmission means can take up considerable space and also consume too much electrical energy.

It is thus an object of the invention to provide a wireless data communication device, which overcomes the drawbacks of the aforementioned prior art and which, in particular, omits additional components to those used for carrying out the internal functions of the device.

The invention thus concerns a wireless data communication device, which includes the features mentioned in claim 1.

One advantage of the communication device according to the invention, lies in the fact that it is not necessary to provide said device with specific transmission means for the transmission of data. These transmission means are formed by the connection structure of one part of an oscillator circuit, which provides high frequency signals. The provision of high frequency signals automatically produces stray signals via the connection structure particularly through a circuit of conductive paths and connected electronic elements. This connection structure thus acts like a transmission antenna for stray signals. Thus, the stray signals can be used to transmit short distance data. Reception means of an electronic apparatus can pick up the stray signals transmitted by the connection structure of the oscillator circuit of the device over a distance that normally does not exceed several centimetres.

Advantageously, the communication device includes radiofrequency signal reception means, and frequency conversion means. These frequency conversion means include the oscillator circuit which can, in turn, include a frequency synthesiser connected to a reference oscillator unit. The synthesiser includes a voltage-controlled oscillator followed by an amplifier, which provides the high frequency signals, a frequency divider and a phase detector. The provision of high frequency signals by the oscillator circuit is thus necessary in the case of a radiofrequency signal receiver.

Using at least one control signal provided to the oscillator circuit by the processing unit, it is possible to transmit data by amplitude or frequency modulating the stray signals. Amplitude modulation of the stray signals is achieved by the control

signal by connecting or disconnecting at least one element of the part of the circuit that provides the high frequency signals. This stray signal amplitude modulation allows a binary data sequence to be transmitted. The stray signal frequency modulation is achieved by at least one control signal preferably by modifying the  
5 division factor of one or two frequency dividers.

The invention therefore also concerns a wireless data communication system, which includes the features mentioned in claim 7.

The objects, advantages and features of the wireless data communication device, and the communication system comprising said device will appear more  
10 clearly in the following description of embodiments of the invention in conjunction with the drawings, in which:

- Figures 1a and 1b show schematically two alternative embodiments of the data communication device according to the invention, which is formed of a radiofrequency signal receiver,  
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- Figure 2 shows schematically the components of a communication system including an electronic apparatus, such as an accumulator charger device and a portable object, in which the communication device is arranged, and

- Figures 3a and 3b show top and side views of the communication system, which includes a charger device and a watch with a data communication device  
20 according to the invention.

In the following description, all of the electronic components of the wireless data communication device or system, which are well known to those skilled in the art in this technical field, will not be explained in detail.

Figures 1a and 1b shows two different embodiments of data communication  
25 device 1. These two embodiments differ from each other solely in the way in which data is transmitted by means of stray signals produced by a connection structure of an oscillator circuit. In the first embodiment, the data is transmitted by modulating the amplitude of the stray signals, whereas in the second embodiment, the data is transmitted by modulating the frequency of the stray signals. This communication  
30 device is preferably formed by a radiofrequency signal receiver 1 which is housed in a portable object, such as a wristwatch.

This communication device 1 includes radiofrequency signal reception means 2, radiofrequency signal frequency conversion means 3, and a signal processing unit 7 receiving intermediate signals  $S_i$  from the frequency conversion means. The  
35 reception means are represented by a reception antenna 2 in Figures 1a and 1b. It should be noted that the received radiofrequency signals are then filtered and amplified in the reception means.

Frequency conversion means 3 are used for lowering the frequency of the signals to be processed in processing unit 7. These frequency conversion means include at least two mixer circuits 4 and 5 for carrying out a double or triple frequency conversion of the radiofrequency signals. In order to carry out a double frequency  
5 conversion, first high frequency signals  $S_H$  and second high frequency signals are provided from an oscillator circuit 6, respectively to mixer circuits 4 and 5. The connection structure of a part 14, 15 of this oscillator circuit, which provides the high frequency signals, is used as a data carrier stray signal transmission antenna as explained hereinafter. This connection structure includes both the electronic elements  
10 of the part of the oscillator circuit, and the conductive paths connecting the electronic elements to each other and to mixer circuit 4.

The first mixer circuit 4 receives the radiofrequency signals and the first high frequency signals  $S_H$  in order to provide first converted signals  $S_R$  to the second mixer circuit 5. The frequency ( $F_{SR}$ ) of the first converted signals is equal, in absolute value,  
15 to the result of the subtraction of the frequency ( $F_{SH}$ ) of the first high frequency signals from the frequency ( $F_{RF}$ ) of the radiofrequency signals in accordance with the formula  $F_{SR} = |F_{RF} - F_{SH}|$ . The second mixer circuit 5 receives the first converted signals  $S_R$  and the second high frequency signals of lower frequency than the first high frequency signals. This second mixer circuit 5 first of all provides second converted signals. The  
20 frequency of these second converted signals is equal to the result of the subtraction of the frequency of the second high frequency signals from the frequency of the first converted signals  $S_R$ . In this second mixer circuit, the second converted signals are sampled and quantified so as to provide intermediate signals  $S_R$  to the processing unit.

25 Oscillator circuit 6 of the communication device includes a frequency synthesiser and an oscillator unit. The frequency synthesiser includes, in a phase lock loop, a voltage controlled oscillator 14 followed by an amplifier 15, which provides the first high frequency signals  $S_H$ , a first frequency divider 16 for the signals provided by the voltage controlled oscillator, and a phase detector 13. The phase detector 13  
30 compares the frequency of the signals provided by the first frequency divider 16 and the frequency of the reference signals provided by the oscillator unit. In order to provide these reference signals, the oscillator unit is formed of a quartz crystal 11 or SAW (Surface Acoustic Wave) oscillator 10, followed by a second frequency divider 12. As a function of the comparison carried out in phase detector 13, an output  
35 voltage of phase detector 13 controls the VCO (voltage controlled oscillator) 14. The VCO thus produces high frequency signals whose frequency depends upon the output voltage of phase detector 13.

The reference SAW oscillator 10 can produce signals whose frequency ranges from 5 to 50 MHz, preferably from 17 to 18 MHz. A division factor of reference divider 12 can be equal to 4 in order to produce reference signals whose frequency is preferably between 4.25 and 4.5 MHz. The frequency of the first high frequency signals  $S_H$  can be comprised between 100 MHz and 5 GHz. Preferably, the frequency of the first high frequency signals can be about 1.5 GHz when the radiofrequency signals are at a frequency, for example, of around 1.57 GHz. Thus, two frequency conversion operations through two mixers can be carried out in frequency conversion means 3. The intermediate signals  $S_I$  have a frequency of the order of 400 kHz to enable them to be processed in processing unit 7.

Since the frequency of the first high frequency signals can be higher than one GHz, stray signals  $S_P$  are automatically transmitted by the connection structure of the elements operating at this high frequency. Thus, by amplitude or frequency modulating first high frequency signals, it is possible to transmit data by means of said stray signals. The predominant frequency of the stray signals is approximately equal to the frequency of the first high frequency signals.

If the communication device is a GPS type radiofrequency signal receiver, signal processing unit 7 includes a correlation stage provided with at least one correlation channel, a microprocessor and storage means, which are not shown. In the correlation stage, these intermediate signals  $S_I$  are processed for example in the well known pseudo-random code control loop and carrier control loop. The data extracted by the microprocessor from the correlation stage can be stored in the memory means, for example, and used for any calculation operations.

The communication device can also be capable of receiving CDMA (Code-Division Multiple Access) type radiofrequency signals. Consequently, signal processing unit 7 has to be arranged for extracting the data contained in the radiofrequency signals.

Signal processing unit 7 is clocked by clock signals CLK provided by oscillator circuit 6 of frequency conversion means 3. These clock signals CLK can be made up of a first clock signal whose frequency is approximately 4.5 MHz, and a second clock signal whose frequency is approximately 250 kHz. The first clock signal is used essentially in the correlation stage, whereas the second clock signal is used in the correlation stage and in the microprocessor.

Once the data from the radiofrequency signals has been processed by signal processing unit 7, a confirmation that these radiofrequency signals have been properly received can be transmitted by means of stray signals  $S_P$ . In order to do this, a control

signal, dependent on the data to be transmitted, is provided by signal processing unit 7 to oscillator circuit 6.

In Figure 1a, control signal  $C_C$  is preferably applied to amplifier 15 of the part of the oscillator circuit that produces the first high frequency signals  $S_H$ . The amplifier, which forms part of the connection structure, is connected or disconnected by control signal  $C_C$  as a function of the data to be transmitted by means of stray signals  $S_P$ . Consequently, the stray signals are amplitude modulated so as to transmit a binary data sequence via such modulation. One binary element of the binary sequence has a value of 1 when the amplitude of the stray signals is maximum, whereas one binary element of the binary sequence has a value of 0 when the amplitude of the stray signals is close to 0. This amplitude modulation by connecting or disconnecting amplifier 15 is called an OOK (On-Off Keying) modulation.

The flow of data transmitted by means of the stray signals can be relatively slow, since the voltage controlled oscillator start time is generally slow. The binary sequence flow can be estimated at 1 bit/10 ms. Consequently, data transmission by means of the stray signals by amplitude modulation can be relatively long depending upon the quantity of data to be transmitted.

In order to transmit the data by amplitude modulation, one could also envisage acting on the electric power supply of several electronic elements of oscillator circuit 6. For example, one could envisage that the control signal allows to connect or disconnect the first frequency divider 16, phase detector 13, voltage controlled oscillator 14 or a combination of these elements.

In Figure 1b, at least one control signal  $C_F$  is applied preferably to the first and second frequency dividers 16 and 12 in order to act on the division factors as a function of the data to be transmitted. The effect of modification of the division factors is to modify the frequency of the first high frequency signals. Thus, it is possible to achieve a frequency modulation of the stray signals for the data transmission. This frequency modulation for the transmission of data by means of stray signals is called an FSK (Frequency Shift Keying) modulation. As in this case, voltage controlled oscillator 14 is not disconnected, the flow of data to be transmitted can be greater than in the case of amplitude modulation.

Of course, the transmission of data by means of stray signals can only occur at a short distance. A stray signal reception apparatus cannot be further than several centimetres from a portable object, which includes the communication device, to pick up the stray signals.

Figure 2 shows the electronic components of a wireless data communication system. The system includes, in this example, an electronic apparatus 30 and a watch

20 provided with the communication device according to the invention. Electronic apparatus 30 constitutes a support for watch 20. Electronic apparatus 30 thus includes a housing 50 for receiving the watch. This housing 50 is preferably fitted to the external dimension of the watch so as to place the watch in a determined position  
5 in the housing of apparatus 30 for the communication of data.

Watch 20 includes, in particular, data communication device 1, which is, in this case, a radiofrequency signal receiver with an antenna 2. The watch also includes a timekeeping circuit 23, control keys 21, a display 22 for the time or for received or transmitted data, a rechargeable battery or accumulator 24 and a charger 25 having a  
10 secondary coil 26. The control keys allow action both on the timekeeping circuit particularly for setting the time and date, and on the radiofrequency signal receiver, particularly for switching said receiver on. Charger 25 enables the battery or accumulator to be recharged in cooperation with a charger of electronic apparatus 30. Charger 25 is operational when the level of voltage detected in the battery or  
15 accumulator is no longer sufficient to ensure that all the functions of the watch will work properly.

The electronic apparatus, which is also used as a charger device for a battery or accumulator of a portable object, essentially includes an RF module 32 for transmitting data by means of radiofrequency signals via an antenna 31, a reception  
20 module 35 for stray signals  $S_p$  via an antenna 34, a main charger 36 of the support apparatus having a primary coil 37, and signal processing means 33, which are connected to all of the electronic elements of the apparatus. The radiofrequency signals transmitted by antenna 31 are picked up by antenna 2 of the radiofrequency signal receiver of watch 20.

25 Chargers 25 and 36, and their coil 26 and 37 constitute a charge module in which coil 37 forms the primary coil of the transformer, whereas the coil 26 forms the secondary coil of said transformer. When the voltage level of the battery or accumulator of the watch is no longer sufficient a battery or accumulator charging operation is carried out. Data concerning the end of battery or accumulator charging  
30 can be transmitted by means of the stray signals. The end of battery or accumulator charging can also be indicated on the apparatus by an electroluminescent diode. Data concerning the proper reception of the radiofrequency signal data can also be transmitted by means of the stray signals.

It should be noted that the battery or accumulator charging module could be  
35 independent of the data communication between the communication device of the watch and the electronic apparatus. A battery or accumulator charging operation can be carried out without the communication device of the watch being switched on.

Signal processing means 33 can store the data received by reception module 35 or provide RF module 32 with the data to be transmitted by means of the radiofrequency signals. Other data can also be exchanged by a connection cable 40 with another unit connected to the apparatus. The electronic apparatus can be directly  
5 connected to a computer station for example.

Figures 3a and 3b show top and side views of the data communication system, which includes the electronic support apparatus 30 and wristwatch 20. Wristwatch 20 can be placed in a determined position in housing 50 of the support apparatus as a function of the position of the signal reception and transmission means of each unit.  
10 As shown in Figure 3b for the reception of stray signals, the watch can only be moved away by a maximum distance  $r$  from the reception module of the apparatus. This distance is of the order of several centimetres.

Electronic apparatus 30 can be connected to an electric power plug by cable 40 or connected to a computer station not shown for the communication of data.

From the description that has just been given, multiple variants of the communication device and the communication system can be conceived by those skilled in the art without departing from the scope of the invention defined by the claims. The frequency modulation can be achieved by modifying the division factor either of the first divider, or the second divider. The data signals transmitted by the electronic apparatus can be acoustic signals, optical signals or other types of signals. The frequency conversion means of the communication device can include only one mixer circuit and one oscillator circuit.